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ABSTRACT

The development of concept usage was studied in 120 normal, mildly retarded, and moderately retarded children. A forced-choice match-to-standard task was used, with the equivalence matches compared with the Ss' explanations of their choices. Among the findings were that performance was related to the stimulus condition (competing versus noncompeting) as well as to mental age and IQ levels, and that appropriate verbal explanations were related to IQ and mental age. Results suggested that mentally handicapped childrens' difficulty is not in applying a construct, but in stating the concept underlying the response. (Author/DLS)

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FINAL REPORT

Project #443AH60087

A Developmental Study of Concept Usage by Mentally Retarded Children

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A DEVELOPMENTAL STUDY OF CONCEPT USAGE BY MENTALLY RETARDED CHILDREN

by

Rosalind Reiss

Philip Reiss

Abstract

The development of concept usage (measured by equivalence formation) in a forced-choice match-to-standard task was studied in normal-IQ children and younger and older mentally retarded children (all equated for mental ages), representing four developmental levels. Both competing contrast choices and non-competing choices were included. These equivalence matches were compared with the children's explanations of their choices using a combination of scoring systems.

Performance on the forced-choice task was found to be related to the stimulus condition (competing versus non-competing) as well as MA and IQ levels. Within the competing-stimulus-condition, MA and IQ level influenced choice of stimulus dimension with normal-IQ, higher MA children making more use of the FI and less use of the PI dimensions as a basis for extracting equivalences. Within the non-competing stimulus condition, all groups showed the same pattern of concept usage responses for each of the four MA and three IQ levels with PE choice occurring most frequently, followed in sequence by FI, FE and PI. Appropriate verbal explanations were related to IQ and MA; children in higher IQ and MA groups stated explanations which more frequently

matched stimulus dimensions pictured for choices than children in lower IQ/MA groups.

While it is often assumed that mentally retarded children are incapable of forming or using abstract concepts, this study points out that the deficit is not in applying a construct (i.e., choice) but in stating the concept underlying the response (explanation).

A Developmental Study of Concept Usage by Mentally Retarded Children

by Rosalind Reiss and Philip Reiss

Although children's performances on concept usage tasks presumably represent the ability to apply previously acquired concepts, comparisons of studies using different tasks indicate that a number of task variables appear to alter concept usage performance, irrespective of ability. These include the number of items required to be processed prior to responding (Blount, 1971; Odom, 1974; Stephens, 1973) and the competing qualities of the comparison stimuli (Birch & Bortner, 1966). The structure of the task (self-initiated or directed responses) and the cues provided (visual model or no visual model) also influence the quality of performance. (Odom, 1974; Landau & Hagen, 1974; Riegel & Taylor, 1974; Stephens, et. al., 1971; Stephens, 1973). In effect, a number of these studies might have tested extraneous processing factors not directly related to the cognitive tasks of abstracting and applying concepts.

The current study attempts to examine abstraction and application abilities by comparing presentations of competing and non-competing stimuli while holding constant task structure, visual cues and number of items to be processed.

Despite the methodological differences of the above studies, there were certain consistent findings. In tasks where stimuli may be related on more than one dimension (stimulus competition) children with normal-IQ do use different dimensions at successive developmental levels. That is, there is a progression from the more frequent use of perceptible to the more frequent use of symbolic dimensions (Riegel & Taylor, 1974; Birch & Bortner, 1966). While children will

respond to those stimulus dimensions which are dominant (stronger) at a given time, it is possible to elicit the use of less dominant attributes by presenting tasks in which stimuli may be related on only one dimension, i.e., stimulus non-competition (Birch & Bortner, 1966). However, no previous study has presented both competing and non-competing choices within four stimulus dimensions to children of four developmental levels. This procedure would more explicitly pinpoint the sequence in relation to developmental level (MA & CA).

Retarded children appear to attend to perceptible dimensions (such as form or color) as well as non-retarded children of the same mental age (Blount, 1971; Stephens, et. al., 1971; Stephens, 1973). However, retarded children appear to have less facility in the use of symbolic dimensions, particularly, those which deal with actions and functions, than do non-retarded children of the same mental age (Blount, 1971; Stephens, 1973). While normal-IQ children at the MA range of 6 - 7 respond to symbolic dimensions more frequently than to perceptible ones (Odom, 1974), retarded children at the MA range of 7.8 - 9.2 still predominantly employ perceptible dimensions (Stephens, 1973). It is not known whether this difference can be accounted for by an inability to use symbolic functions (developmental deficit) or whether it represents a lag in learning to process more complex stimuli (developmental delay). The reported differences may also be accounted for by disparities in task processing demands, as discussed above. The current study attempts to clarify this issue by comparing the performance of mildly and moderately retarded children with normal-IQ children at four CA and MA levels, while holding task structure constant. The procedure limited the number of items which require processing

prior to responding and provided a usual standard (visual cue), thus minimizing extraneous processing factors not directly related to the cognitive task.

A rather different set of findings has been reported in studies which asked retarded children to both choose related stimulus items and to explain the basis for the relationship. That is, while the ability to use more mature bases for choosing related items has been found to be generally related to MA, the ability to explain the relationship seems more likely to be related to CA and, to a lesser degree, to IQ. Both normal-IQ and retarded children improve with age in their ability to explain the bases of their choices (Dickie & Denny, 1973; Landau & Hagen, 1974).

Retarded children appear to have less facility in explaining both their perceptible and symbolic choices than do normal-IQ children of the same mental age (Blount, 1971; Dickie & Denny, 1973; Landau & Hagen, 1974). These discrepancies between apparent conceptual attainment and inabilities to explain responses may be indicative of the retarded children's relative inability to synthesize extracted visual information in order to formulate a construct. Findings that retarded children have less facility than do normal-IQ children of the same mental age in the use of symbolic dimensions, coupled with findings that retarded children have difficulty explaining the bases for their choices, indicate that they may be attending solely to perceptible similarities at a perceptual rather than the conceptual level. Unless both the concept attainment behaviors and verbal explanations are analyzed, one cannot be certain whether retarded children are unable to state explanations for their choices because they are simply not abstracting critical attributes of stimulus dimensions at the symbolic level (developmental deficit) or because the development of this

explanation ability is delayed among retarded children. Support for a delay in relation to chronological age is found when comparing Blount's (1971) findings that mildly retarded children (MA 7, CA 12) were unable to explain choices with McConkey & Herriot's (1973) findings that moderately retarded children (MA 7, CA 24) were able to explain choices. In the current study, a direct comparison of retarded children of the same MA but different CA levels was possible by selecting subjects from both mildly amd moderately retarded groups. All children were presented with the same task and asked to explain their choices.

Procedures

Subjects

Twelve groups of ten children each were selected to represent each of four developmental levels as measured by mental ages (MA) within each of three IQ levels (normal, mildly retarded, moderately retarded). The Peabody Picture Vocabulary Test (PPVT) was administered to children at various age levels: normal-IQ children at ages 72, 96, 120 and 144 months; mildly retarded children at ages 107, 143, 179 and 215 months; and moderately retarded children at ages 167, 223, 279 and 334 months. The PPVT provided information on current developmental levels for all subjects. Analyses of variance were performed for MA and CA. (Mean and standard deviations for CA and MA are presented in Tables 1 and 2). It was found that there were no significant differences between the three IQ groups in MA within each of the four MA levels, although differences between MA levels were significant. Also, there were, as expected, significant differences in chronological ages.

Older (TMR) and younger (EMR) groups of retarded children of the same mental age were selected from classrooms designated for either the mildly

TABLE 1

Means and Standard Deviations of Subjects'

Chronological Ages

Chronological Ages					
Normal IQ		Younger Retarded		Older Retarded	
Mean	SD	Mean	SD	Mean	SD
72.3	3.53	115.5	16.67	167.4	12.51
99.3	5.33	152.2	9.62	234.6	14.85
121.0	3.30	186.5	10.58	284.5	14.15
141.1	2.38	209.6	15.33	333.1	11.52

TABLE 2

Means and Standard Deviations of Subjects'

Mental Ages

Mental Ages						
Normal IQ		Younger Retarded		Older Retarded		
Mean	SD	Mean	SD	Mean	SD	
69.7	10.06	66.9	12.06	67.3	15.41	MA 6
102.1	9.95	99.2	10.64	99.7	5.3	8
119.5	11.67	110.3	14.62	115.5	5.58	10
139.8	20.46	131.0	17.85	126.6	21.78	12

retarded (younger) or moderately retarded (older). The school-age mentally retarded children were selected through the New York City Division of Special Education Pupil Personnel Service. Subjects with a CA of 21 years or more were selected from the A.C.R.M.D. Occupational Day Center.

Methods and Materials

A series of 60 triads (each composed of a standard and two choice items) were presented, one at a time, to each child. The picture items consisted of 5 x 5 cm line drawings mounted on a 27.5 x 20.0 cm posterboard with the index item in an apex position and the two choice responses 5 cm below and 4 cm apart as portrayed in Figure 1. The child was required to compare the two stimuli at the base and choose the one which matched the standard, or index, at the apex. The triads were presented in the same random order to all children.

Since none of the three visual stimuli in each triad are identical perceptual matches, the child was forced to extract similarities from the visual representations in order to determine which two are equivalent. Four stimulus dimensions were used, two at the perceptible level and two at the symbolic or functional level. The four stimulus dimensions (Oliver & Hornsby, 1966) from which the child could from equivalences were:

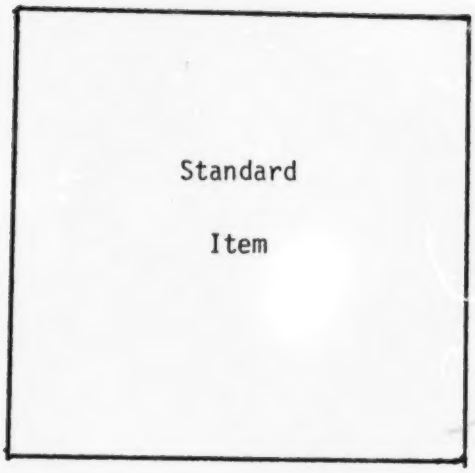
(1) perceptible intrinsic - similarity in shape or form (PI)

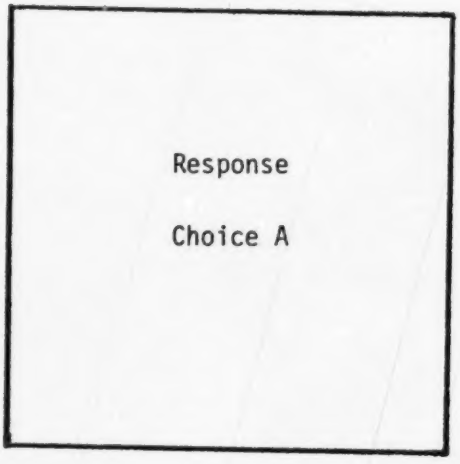
(2) perceptible extrinsic - spatial or temporal contiguity (PE)

(3) functional intrinsic - active use, purpose (FI)

(4) functional extrinsic - object or recipient of function or action (FE)

The response items were designed to direct attention to a particular





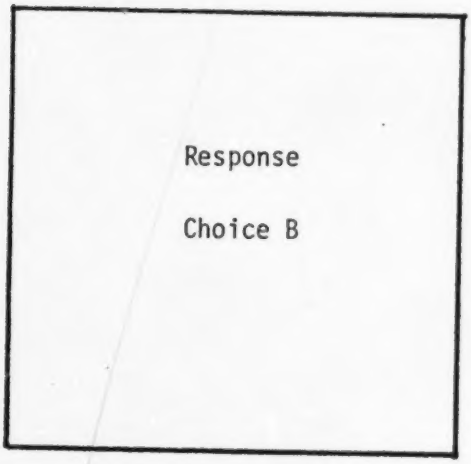


Figure 1. Example of a triad.

dimension. Two independent judges determined the dimensions cued for each of the triads.

Two types of response choice situations were used: (1) competing contrast choices and (2) non-competing choices. In the competing contrast stimulus situations each of the response choices is related to the index picture along a different dimension. Each response choice is therefore potentially equivalent to the index item and each is presumably competing for the child's attention and selection. Since the child is required to select only one of the two response choices, he presumably responds to the more dominant of the two. There are six possible combinations of contrast choices between the stimulus dimensions: PI-PE; PI-FI; PI-FE; PE-FI; PE-FE; and FI-FE. These were paired in 36 of the triads, thus forcing the child to choose between each possible combination four times (Table 3). No index item was used more than once for a competing choice. Each dimension choice was presented with equal frequency in the left-right position choices.

In the non-competing stimulus situation, only one of the response choices is related to the index item through an equivalent stimulus dimension match. The other item is a filler item selected to minimize any objective relationship to the index item. Each of the four stimulus dimensions were presented four times, alternating left-right position with the filler items. The child was presented with sixteen triads of non-competing contrast choices (see Table 3).

For each of the triads, the child was directed to look at the index item. He was then directed to look at each of the response items and was asked to decide which one of the response items goes with the index item. He was then asked to explain his choice. The directions were given with physical prompts

TABLE 3

Triad Combinations

Condition	Relationship Between Index and		N
	Choice A	Choice B	
non-competing	perceptible intrinsic	filler	6
non-competing	perceptible extrinsic	filler	6
non-competing	functional intrinsic	filler	6
non-competing	functional extrinsic	filler	6
		Sub-total	24
competing	perceptible intrinsic	perceptible extrinsic	6
competing	perceptible intrinsic	functional intrinsic	6
competing	perceptible intrinsic	functional extrinsic	6
competing	perceptible extrinsic	functional intrinsic	6
competing	perceptible extrinsic	functional extrinsic	6
competing	functional intrinsic	functional extrinsic	6
		Sub-total	36
		Total	60

as follows:

(1) "See this." (point to the index item)

(2) "Look at these." (point to each of the response items)

(3) "Which one of these (again point to the response items) goes with this?" (again point to the standard item)

(4) "Why do these go together?" (point to the index and child's choice)

In an attempt to ensure that the child is actually looking at each of the stimuli, the experimenter, when necessary, physically directed attention (i.e., moving the child's head, pointing from the child's eye to the pictorial stimuli).

Each choice was noted on a response sheet kept out of view. When a child did not respond after approximately 10 seconds, the entire set of directions was repeated.

The child's explanations were tape recorded. These verbal explanations were classified by two independent judges using a combination of the system originally described by Olver & Hornsby (1966) with later modifications by Stephens, et.al. (1971). These following categories tap all possible verbal responses:

(1) perceptible intrinsic - description of physical properties (e.g., They are both round.)

(2) perceptible extrinsic - description of position in time or space (e.g., They go on a table.)

(3) functional intrinsic - description of what the items can do, their purpose (e.g., We use them to light up a room.)

(4) functional extrinsic - description of what can be done to the

items (e.g., They can both be burned.)

(5) fiat equivalence - statement simply re-affirming equivalence (e.g., They just do go together.)

(6) nominal - statement using superordinate term (e.g., They are both animals.

(7) quasi-equivalence - statement linking items grammatically (e.g., The cat chases the mouse.)

(8) no explanation - statement does not apply to any of the above.

Two experimenters were used, each of whom gave half the children the PPVT and the other half the concept-usage task. They were trained in the use of the materials and recording devices but were not given any information about the purpose of the investigation.

The following hypotheses were tested:

I. Under the competing condition, a hierarchical progression of preferential dimension selection will be found.

1. Normal-IQ children of higher mental ages will more frequently use the symbolic (functional) dimensions than the perceptible dimensions while normal-IQ children of lower mental ages will more frequently use the perceptible dimensions than the symbolic dimensions.
2. Within the perceptible dimensions, normal-IQ children of higher mental age will more frequently use the extrinsic perceptible dimension than the intrinsic perceptible dimension.
3. Within the symbolic dimensions, normal-IQ children of higher mental age will more frequently use the intrinsic functional dimension than the extrinsic functional dimension.

II. Under the non-competing condition preferential dimension selection is related to mental age.

1. Children with higher mental ages use a greater variety of dimensions than children with lower mental ages, regardless of CA or IQ.
2. All children gain access to each successive stimulus dimension at the same MA.

III. Under the competing condition preferential dimension selection is related to both MA and IQ.

1. All mentally retarded children will attain dominance for each successive dimension at a higher MA than normal-IQ children.
2. Mentally retarded children will never attain dominance for extracting symbolic properties.

IV. Verbal explanations for choices is related to IQ and CA rather than MA.

1. At each mental age level, older retarded children will more frequently offer verbal explanations that match the level of their conceptual choice than will the younger retarded children.
2. At each mental age level normal-IQ children will more frequently offer verbal explanations that match the level of their conceptual choice than will either mentally retarded group.
3. All children will more frequently be able to offer correct verbal explanations after a particular stimulus dimension has achieved dominance (as measured by the competing situation), than before dominance is achieved.

Results

Data on the forced choice task were analyzed in a four-dimensional design, with IQ (3 levels) and MA (4 levels) as between-subjects variables and stimulus condition (2 levels) and stimulus dimension (4 levels) as within-subjects variables (Table 4). This analysis revealed a significant four-way interaction. Selected sub-analyses were performed to interpret the interaction and to test specific hypotheses of this study.

Hypothesis I was investigated by a three-way analysis of variance (Table 5) of scores of normal-IQ Ss (level C2 of the four-way analysis); stimulus condition and stimulus dimension were within-subject factors and mental age was a between-subject factor. Here there was a significant three-way interaction. This indicated that within the conflicting conditions, for normal-IQ Ss, the different effects of the mental age by stimulus dimensions depended upon mental age levels. Therefore, a mental age by stimulus dimension analysis was performed (Table 6). After finding significant interaction, individual cell means were compared. This indicated that the functional-intrinsic (FI) stimulus dimension was used significantly more frequently at MA 12 ($\bar{X}$ = 12.1) than at MA 6 ($\bar{X}$ = 8.2) and MA 8 ($\bar{X}$ = 11.3). At MA level 6 the perceptible-intrinsic (PI) stimulus dimension was used signficantly more frequently ($\bar{X}$ = 9.9) than for any of the higher MA groups (MA 8, $\bar{X}$ = 6.1; MA 10, $\bar{X}$ = 7.3; MA 12, $\bar{X}$ = 6.2). Use of the perceptible-extrinsic (PE) dimension peaked at MA 8 ($\bar{X}$ = 12.1) and 10 ($\bar{X}$ = 10.6) but these increases were not significant. There was no significant difference in the use of the functional extrinsic (FE) dimension across the four MA levels.

Comparisons of frequencies of use for each stimulus dimension by

TABLE 4

Analysis of Variance of Choice Scores

Source	df	ss	ms	F
Between Ss	119	122.4		
C[a]	2	20.7	10.4	13.0*
D[b]	3	16.5	5.5	6.87*
CD	6	1.5	0.3	.4
error b	108	83.7	0.8	
Within Ss	840	8930.7		
A[c]	1	3623.2	3623.2	1050.2*
B[d]	3	1348.2	449.4	130.2*
AB	3	784.6	261.5	75.8*
AC	2	16.7	8.4	2.43
AD	3	17.1	5.7	1.65
BC	6	99.0	16.5	4.78*
BD	9	121.1	13.45	3.90*
ABC	6	65.0	10.8	3.13*
ABD	9	86.5	9.6	2.78*
BCD	18	20.8	1.2	0.35
ACD	6	1.4	0.2	0.06
ABCD	18	138.5	7.69	2.23*
error w	756	2608.6	3.45	
SS_T	959	9053.1		

[a]C = CA. [b]D = Ma. [c]A = stimulus condition. [d]B = stimulus dimension. *$p < .01$.

TABLE 5

Analysis of Variance of Choice Scores: Normal IQ Subjects

Source	df	ss	ms	F
Between Ss	39	36.97		
C[a]	3	6.18	2.06	2.42
error b	36	30.79	0.85	
Within Ss	280	2405.45		
A[b]	1	990.53	990.53	1320.7*
B[c]	3	229.13	76.38	16.32*
AB	3	153.59	51.20	21.5*
AC	3	5.435	1.82	2.43
BC	9	80.61	8.96	1.91
ABC	9	156.50	17.39	7.31*
error w	252	789.66	3.13	
$error_1$ w	36	27.54	0.75	
$error_2$ w	108	505.23	4.68	
$error_3$ w	108	256.89	2.38	
Total	319	2442.42		

[a] C = Ma

[b] A = stimulus condition

[c] B = stimulus dimension

*$p < .01$

TABLE 6

Analysis of Variance of Choice Scores: normal subjects, non-competing stimulus condition.

Source	df	ss	ms	F
A[a]	3	0.13	.04	.001
B[b]	3	376.18	125.4	24.7*
Cells	15	606.6		
AB	9	230.29	25.59	5.03*
Within cells	144	731.3	5.08	
Total	159	1337.9		

[a]A = MA

[b]B = stimulus dimensions

*$p < .01$

normal-IQ Ss at each MA level show different patterns or sequences of use. At MA 6, the pattern of use was PI > PE > FI > FE, that is PI was used most frequently followed in sequence by PE, FI and FE. However, no dimension was dominant, that is, none was used significantly more frequently than at least two other stimulus dimensions. At MA 8 the order of use was PE > FE > FE > PI. Here PE ($\overline{X}$ = 12.1) and FI ($\overline{X}$ = 11.3) were used significantly more frequently than either FE ($\overline{X}$ = 6.5) or PI ($\overline{X}$ = 6.1). MA 10 showed the same pattern as MA 8 with PE ($\overline{X}$ = 10.6) and FI ($\overline{X}$ = 10.1) also used significantly more frequently than either FE ($\overline{X}$ = 7.9) or PI ($\overline{X}$ = 7.3). Therefore, at MA 8 and 10 both PE and FI are dominant. At MA 12 the pattern of use was FI > PE > FE > PI with FI ($\overline{X}$ = 12.1) used significantly more frequently than any of the other stimulus dimensions while PE ($\overline{X}$ = 9.8) was used significantly more frequently than PI ($\overline{X}$ = 6.1). Therefore, at MA 12 FI is dominant.

There were also significant differences in the use of the internal and external properties within the perceptible and functional dimensions at all mental ages except the youngest (MA 6) where there were no differences in the use of any of the dimensions. For MA 8, 10 and 12 there was significantly more use of the extrinsic perceptible dimension than the intrinsic perceptible dimension (MA 8: PE, $\overline{X}$ = 12.1; PI, $\overline{X}$ = 6.1; MA 10: PE, $\overline{X}$ = 10.6; PI, $\overline{X}$ = 7.3; MA 12: PE, $\overline{X}$ = 9.8; PI, $\overline{X}$ = 6.2). Also, there was significantly more use of the intrinsic functional dimension than the extrinsic function dimension (MA 8: FE, $\overline{X}$ = 11.3; FE, $\overline{X}$ = 6.5; MA 10: FI, $\overline{X}$ = 10.5; FE, $\overline{X}$ = 7.9; MA 12: FI, $\overline{X}$ = 12.17; FE, $\overline{X}$ = 7.9).

Hypothesis I, thus, was partially confirmed. While normal-IQ children of higher mental ages did more frequently use the symbolic (functional) dimension

of FI, there was no increase in the use of the stimulus dimension of FE, also designated as a symbolic dimension. In fact, the FE dimension showed no change across MA levels. While there was a significant difference in the usage of the PI dimension across MA levels, with the lowest MA group (MA 6) using PI significantly more frequently than the higher MA groups, PI was not used significantly more frequently than the other dimensions at MA 6. Also, while PE was used significantly more frequently than the other stimulus dimensions at MA 8 and 10, there were no significant differences in the use of the PE dimension across MA levels. However, it can be inferred from the above results, that there is a change in the usage of the stimulus dimensions with increased mental age with the order of use being PI, PE, and then FI. FE was eliminated since it showed no change across mental age and was not the dominant dimension at any mental age.

Hypothesis II was tested through a three-way analysis (Table 7) of variance of scores on the forced-choice task in the non-competing stimulus condition (level A1 of the four-way analysis of variance), with MA and IQ as between-subject factors and stimulus dimension as a within-subject factor.

Scores for Hypothesis II were the number of instances of choice of the stimulus dimension rather than the filler item. There were significant differences across groups in the number of correct responses, as defined by the choice of the stimulus item rather than the filler item. Each of the main effects was found to be significant. All groups make the most use of PE ($\overline{X}$ = 22.26), less use of FI ($\overline{X}$ = 20.4), followed by FE ($\overline{X}$ = 20.3) and then PI ($\overline{X}$ = 18.8). There is significantly greater use of the PE dimension compared to use of each of the others. There is also significantly greater use of FI

TABLE 7

Analysis of Variance of Choice Scores: non-competing stimulus condition

Source	df	ss	ms	F
Between Ss	119	394.4		
B[a]	3	33.48	11.16	3.91*
C[b]	2	37.3	18.65	6.54*
BC	6	15.92	2.65	
error b	108	307.7	2.85	
Within Ss	360	285.5		
A[c]	3	45.27	15.09	21.3*
AB	9	3.68	0.41	
AC	6	4.13	0.69	
ABC	18	2.92	0.16	
error w	324	229.5	0.71	
Total	479	679.9		

[a]B = MA

[b]C = IQ

[c]A = stimulus dimensions

*$p > .01$

compared to PI and of FE compared to PI. However, there is no significant difference between the use of FI and FE.

The number of correct responses increased with mental age with children at MA 8 ($\overline{X}$ = 20.5), MA 10 ($\overline{X}$ = 21.0) and MA 12 ($\overline{X}$ = 21.6) making significantly more correct choices than children at MA 6 ($\overline{X}$ = 18.7). Other differences between MA levels were non-significant. Also, normal-IQ children made significantly more correct choices ($\overline{X}$ = 22.0) than those children in either the mildly ($\overline{X}$ = 19.9) or moderately retarded ($\overline{X}$ = 19.4) groups. That is, while the sequence of the frequency of accurate use for each stimulus dimension was the same for all groups (FE > FI > PE > PI), there were significant differences between groups in the total number of accurate choices.

Hypothesis II, thus,was not confirmed. Children at higher mental ages did not use a greater variety of dimension than children with lower mental ages. Instead, at all four MA levels and at all three IQ levels, the frequency of correct choice for each stimulus dimension produced the same sequence. That is, the stimulus dimension PE was most frequently chosen accurately followed in sequence by FI, FE and PI. There were, however, differences between the three IQ levels and the four MA levels in their total number of correct choices with normal-IQ children and those at higher mental ages making more correct choices.

Hypothesis III was tested through a three-way analysis of variance (Table 8) of scores in the competing condition (level A2 of the four-way analysis of variance). There were AB and AC interactions (stimulus dimensions X MA and stimulus dimension X IQ). Cell means for each interaction were compared (Table 9) by Duncan's Multiple Range Test.

It was found that except for the normal-IQ oldest and youngest groups

TABLE 8

Analysis of Variance of Choice Scores:

competing stimulus condition

Source	df	ss	ms	F
Between Subjects	119	4.25		
B[a]	3	0.08	.03	
C[b]	2	0.11	.06	1.50
BC	6	0.185	.03	
error b	108	3.875	.04	
Within Subjects	360	4745.75		
A[c]	3	2087.6	695.9	104.8*
AB	9	203.89	22.6	3.4*
AC	6	159.8	26.6	4.01*
ABC	18	143.2	7.96	1.19
error w	324	2151.26	6.64	
Total	479	4750		

[a] B = MA

[b] C = IQ

[c] A = stimulus dimensions

*p > .01

TABLE 9

Cell Means: Choice Responses, Conflicting Stimulus Condition*

Stimulus Dimensions	Perceptible Extrinsic				Functional Intrinsic				Functional Extrinsic				Perceptible Intrinsic			
MA	6	8	10	12	6	8	10	12	6	8	10	12	6	8	10	12
Normal IQ	9.8	12.1	10.6	9.8	8.2	11.3	10.5	12.1	8.1	6.5	7.9	7.9	9.9	6.1	7.3	6.2
Mildly Retarded	12.5	12.2	13.0	12.6	9.2	9.1	9.5	11.2	8.2	8.0	7.1	7.8	6.1	6.5	6.3	4.4
Moderately Retarded	11.3	12.3	12.6	13.0	9.5	10.3	9.7	10.3	7.6	7.6	7.5	7.2	7.6	5.8	6.2	5.3

*C. diff. = 2.26

(MA 6 and MA 12), all other MA-IQ combinations followed the same sequence in the frequency of use of each of the stimulus dimensions. That is, these groups used PE most frequently, followed in use by FI, FE and PI. While not all of these frequency differences reached significance, certain comparisons were always significant. PE was always used significantly more frequently than FE and PI. In comparison, for the youngest normal-IQ children there were no significant differences in dimension usage. For the oldest normal-IQ group the sequence of usage was FI > PE > FE > PI with significant differences found between FI and PE, PE and FE, and PE and PI.

Comparisons of the use of each of the stimulus dimensions across mental age groups reveal more variability among the normal-IQ groups than for any of the mentally retarded groups. With increased mental age (MA 6 versus 8 and MA 6 versus 12) there was significant increased usage of FI. Similarly, there was significant decreased usage of PI (MA 6 versus 8, 10 and 12). There was also a significant increase for the stimulus dimension PE between MA 6 and 8. In contrast, for the mentally retarded children, there was only one significant difference in the use of stimulus dimensions across MA levels. While there was the increase in the use of the FI dimension and decrease in the use of the PI dimension with increased mental age, the only significant difference was for the moderately retarded children's use of the PI dimension (MA 6 versus MA 12).

Comparisons between normal-IQ and mentally retarded groups at the same MA level reveal few significant differences. There were no differences in the usage of the stimulus dimension FE or FI for children at the same MA level. Thus, while the stimulus dimension FI was used significantly more

at MA 12 only by the normal-IQ children, usage of the FI dimension was not significantly different at MA 12 across IQ groups. Also, there were no significant differences for the dimension PI except at MA 6, where normal-IQ children make significantly more use of the PI dimension than do children at any of the other MA-IQ groups. There were significant differences in the usage of the stimulus dimension PE with mildly retarded children at MA 6, 10 and 12 making significantly more use of the stimulus dimension PE than normal-IQ children of the same MA. Moderately retarded children, however, were not significantly different than the normal-IQ children except at MA 12 where the moderately retarded children also showed significantly more use.

Hypothesis III, thus is partially confirmed. Under the competing condition preferential dimension selection is related to MA and IQ levels, although the relationship is different for each stimulus dimension. Higher MA, normal-IQ children make more use of the stimulus dimension FI. Also, while normal-IQ children at MA 12 attained dominance for the stimulus dimension FI, mentally retarded children did not. However, progression of use of the stimulus dimensions was not delineated clearly enough to confirm whether retarded children did in fact attain dominance for each successive dimension at higher mental ages than normal-IQ children.

The explanations were initially scored in an 8-category system, based on systems described by Olver & Hornsby (1966) and Stephens, Nopar & Gillam (1971). Inspection of these data indicated such marked departure from normal distribution that further formal analysis was deemed unadvisable. Instead, the median values for each category are reported in Table 10. Four of the explanation categories correspond to the stimulus dimensions; four others are

TABLE 10

Median Scores for Verbal Explanations

	Verbal Explanations							
	PE	PI	FE	FI	Fiat	Nominal	Quasi	None
Normal-IQ								
MA 6	14.5	14.0	5.0	10.5	0.5	0.5	0.5	6.5
MA 8	18.5	10.0	9.5	13.5	1.5	1.5	1.0	3.0
MA 10	17.6	13.0	11.0	12.0	0.0	4.0	1.0	2.5
MA 12	16.0	9.5	11.5	16.5	0.5	2.0	1.0	2.0
Mildly Retarded								
MA 6	8.0	0.5	1.5	1.5	0.5	0.0	1.0	25.0
MA 8	14.0	2.5	7.0	7.0	2.0	1.0	1.5	15.0
MA 10	16.5	3.5	6.5	7.5	3.0	1.0	2.5	14.5
MA 12	15.0	5.5	7.0	11.0	0.5	2.0	0.0	15.0
Moderately Retarded								
MA 6	1.5	0.0	0.0	0.0	3.0	0.0	0.0	38.5
MA 8	8.5	1.5	2.0	4.0	1.0	0.0	0.0	37.5
MA 10	10.5	1.0	4.0	6.5	1.0	0.0	2.0	14.5
MA 12	13.0	1.0	3.5	7.5	0.5	0.0	1.5	24.5

used to account for explanations that do not match the stimulus dimensions. As can be noted, the explanations given by mentally retarded children were frequently in the latter four categories. That is, more than half the explanations given by mentally retarded children could not be scored in terms of the concepts expressed by the picture choices.

However, the explanations which could be scored in the four stimulus dimension categories were used to test Hypothesis IV. A three-dimensional design in which MA and IQ are between-subject variables and stimulus dimensions is the within-subject variable. Table 11 was computed. This analysis showed a significant three-way interaction, revealing that both MA and IQ influenced whether the child offered explanations that matched their choices. Duncan's Multiple Range Test (Table 12) was utilized to test the specific predictions in Hypothesis IV and to determine which specific comparisons were significant. It was found that normal-IQ children more frequently explained their choices by correctly stating the stimulus dimension that was pictured than did children in either group of mentally retarded subjects. This finding held true for all mental age levels and all stimulus dimensions except for PE responses at MA 10 and 12 where the differences were not significant. Within the same MA level, younger mildly retarded children more frequently offered verbal explanations that matched the level of their conceptual choice than did the older moderately retarded children. These differences were significant for the PE and FI dimensions at all MA levels but were significant for only MA 8 and 12 in the FE dimension and MA 12 in the PI dimension. Also, at all IQ levels, for stimulus dimensions PE, FI and FE there was an increase of explanations that matched the response

TABLE 11

Analysis of Variance of Explanation Scores

Source	df	ss	ms	F
Between Ss	119	7245.0		
B[a]	2	3587.75	1793.87	75.98*
C[b]	3	1021.989	340.663	14.43*
BC	6	85.68	14.28	<1
error b	108	2549.577	23.61	
Within Ss	360	7514.89		
A[c]	3	2760.773	920.26	240.9*
AB	6	188.346	31.39	8.22*
AC	9	322.569	35.84	9.38*
ABC	18	3005.687	166.98	43.7*
error w	324	1237.5587	3.82	
Total	479	14759.898		

[a]B = IQ level

[b]C = MA level

[c]A = stimulus dimensions

*$p < .01$

TABLE 12

Cell Means: Explanation Scores*

Stimulus Dimensions	Perceptible Extrinsic				Functional Intrinsic				Functional Extrinsic				Perceptible Intrinsic			
MA	6	8	10	12	6	8	10	12	6	8	10	12	6	8	10	12
Normal IQ	10.6	15.8	14.9	13.6	7.4	12.1	11.7	14.9	4.8	8.5	10.0	10.7	8.9	7.5	9.1	8.1
Mildly Retarded	7.7	11.2	13.2	13.1	3.7	6.6	8.0	9.4	2.2	4.6	5.4	6.4	1.4	2.1	3.7	3.9
Moderately Retarded	3.0	7.0	7.1	9.2	1.5	3.8	5.9	7.0	1.3	1.8	3.9	3.7	1.3	2.3	2.4	0.8

*C. diff. = 1.71

choice with increased MA with children at MA 6 making significantly fewer explanations than children at MA 12. However, for the PI dimension there was a significant increase only for the mildly retarded children.

Verbal explanations for choices, therefore, are related to IQ and MA, not to CA as had been predicted. Explanations more frequently matched stimulus dimension choices in higher IQ and MA groups, regardless of CA. While it had been predicted that children would more frequently offer correct verbal explanations after a particular stimulus dimension had achieved dominance, than before dominance was achieved, this prediction could not be tested at this time since dominance could not be established for each stimulus dimension.

In sum, the choice of stimulus dimension used for the purpose of matching an index item seems related to the stimulus condition of competing versus non-competing as well as IQ and MA levels. In the competing stimulus condition, MA and IQ levels influenced choice of stimulus dimension with normal-IQ, higher MA children making more use of the FI and less use of the PI dimensions. (Hypothesis I & III) In the non-competing stimulus condition, however, while MA and IQ level affected the number of correct choices (stimulus dimension rather than filler), they did not affect the relative use among the four stimulus dimensions. At each IQ and MA level, the frequency of correct responses was always greatest for the stimulus dimension PE followed by FI, FE and then PI (Hypothesis II). It may be that the strength of the stimulus is so great as to mask the performance differences related to stimulus condition, MA or IQ. Verbal explanations which state the concept underlying the response choice are related to IQ and MA, not CA as had been predicted (Hypothesis IV).

Discussion

In this study an attempt was made to clarify the bases for disparities between the performance of retarded and normal-IQ children on concept usage tasks. Both use of specific stimulus dimensions as a basis for equivalence formation and verbal explantions for these choices were examined in an attempt to determine whether abstracting disabilities in retarded people represents developmental delays or deficits.

Changes in use of stimulus dimensions on forced-choice tasks by older and younger retarded children and normal-IQ children at each of four mental age levels were compared. Both competing choice and non-competing choice conditions were used. By systematically varying the relations among the stimulus dimensions in the competing choice conditions, it was possible to ascertain the dimensions to which each group of children responded most frequently. In the non-competing choice condition, only one stimulus item matched the standard, the second choice was a filler with no apparent relation to the index item. Under this condition, it was possible to ascertain whether, at each developmental level particular stimulus dimension relationships are available for use by each group of children. By comparing the children's explanations with their choices, it was possible to examine whether or not the ability to employ specific stimulus dimensions in a perceptual matching task is paralleled by the ability to express the concept by stating the basis for having selected the match.

Preferential use of stimulus dimensions as a function of mental age in a forced-choice match-to-standard task has previously been reported for

normal-IQ children. Previous research has shown that as children mature they more frequently choose items related functionally and less frequently choose items related perceptually when both possibilities are available in the choices. It was predicted, therefore, that the normal-IQ children in this study would show a similar change in preferential selection when responding to the particular stimulus items used. That is, there would be a change in the preferential use of the stimulus dimensions with increased mental age. The order in which dimensions were expected to emerge as dominant was PI, PE, FE and then FI.

While Hypothesis I, regarding this hierarchial developmental sequence for the competing choice condition was only partially confirmed, the results do, in general, conform to the findings of previous research (Riegel & Taylor, 1974; Birch & Bortner, 1966). Normal-IQ children showed increasing use of functional stimulus dimensions and decreasing use of perceptual dimensions as mental age increased. Frequencies of use were compared at each mental age level (for all dimensions) as well as across mental ages (for each dimension). It was found that the PI dimension is more often used by children of MA 6 than by children of any other MA; although even at MA 6 the PI dimension is not used significantly more often than the other stimulus dimensions. Thus, although it cannot be said to be dominant at MA 6 (Perhaps dominance is achieved earlier, and this MA level represents a transition to the dominance of another dimension), it is used more often at MA 6 than at later levels.

The PE dimension may be said to be dominant at MA's 8 and 10 since it is used significantly more frequently than either the PI or FE dimensions. Also, it is used more frequently by children of these MA levels (8 and 10) than by

children of MA 6, although the difference is not statistically significant.

At MA 12 the FI dimension has clearly achieved dominance; it is used significantly more often than any of the three other dimensions by children of this MA level and, as well, it is used significantly more often by children of MA 12 than by children of MA 6.

The FE dimension shows no significant changes in frequency of use over the four MA levels included in this study nor was it ever the preferred stimulus dimension at any one MA level. It is possible that this dimension becomes dominant at some later MA level. It is also possible that the particular relationships among items selected for this study did not portray this dimension with sufficient clarity.

The definitions and characteristics of the stimulus dimensions could themselves be the subject of further study. Simple dichotomous categorization may be appealing and may seem valid, a priori, but there may indeed exist finer gradients or certain other more compelling modes of establishing relationships. Each dimension consists of several variables which may establish a relationship (for example, PI may refer to size, shape or color); such variables may not be of equal potency.

However, despite such considerations, the results obtained here do support the following: (1) the stimulus items which composed the concept usage task do indeed evoke preferential use of stimulus dimensions (except for the FE dimension) in a forced-choice task and (2) in the competing choice condition, normal-IQ children's choices based on perceptual dimensions show decreased use with increasing mental age while choices based on functional dimensions show increased use with increasing mental age (Hypothesis I).

Comparisons of the performance of each of the IQ-groupings of children on the two stimulus presentation conditions (competing or non-competing) can now be discussed. First of all, all children, regardless of IQ or MA, appear to have the ability to recognize and use relationships corresponding to each of the four stimulus dimensions, in the non-competing stimulus condition. Thus, both groups of mentally retarded children and the young normal-IQ children were able to make choices based on the supposedly more "mature" dimensions of FE and FI. Children in all groups made most frequent use of the PE dimension, followed in order of frequency by the FI, FE and PI dimensions - in the non-competing stimulus presentation.

However, differences among the groups appear when we consider the use of each stimulus dimension in the competing stimulus presentation condition. Here it is found that at MA 12, normal-IQ children use the FI dimension more often than do children in either group of mentally retarded subjects of the same MA.

Most previous studies have used only one stimulus presentation and have not considered the effects of competing versus non-competing presentations upon choices. If only a competing stimulus presentation were used, differences between normal-IQ children and mentally retarded children would have emerged and, as has been done in earlier studies, interpreted as an inability of mentally retarded children to make use of symbolic (i.e., functional) stimulus dimensions. However, since this was not found to occur in the non-competing stimulus presentation, other interpretations must be considered.

One consideration is the possible effect of having been exposed to both stimulus conditions within a single task. The task was structured so that each

subject was given 24 non-competing choices followed by 36 competing choices. No previous research had compared the effects of the two forms of presentation across IQ and MA groups. There was no suggestion that different results would be obtained. Given the current findings, it appears worthwhile to systematically vary the order of presentation in a future study in order to evaluate the practice effects as well as to be able to compare more carefully the performance of the same subjects, or comparable groups of subjects on two versions of the task.

The competing and non-competing stimulus conditions may tap different behaviors. While both require the ability to recognize and use a relationship based on a stimulus dimension, the competing stimulus condition requires additional processing behaviors. That is, in the competing stimulus condition the children need to choose which of two possible dimensions will be used. It is not known whether the child first recognizes both and chooses to respond to a "preferred" dimension or if only the first to be recognized is used. A study of response times, scanning behavior and comparisons of responses to the same items in both conditions could help resolve this. It would be interesting to note relationships between this performance and those which have been related to measures of reflectivity/impulsivity.

Reponse choice may be a function of familiarity with particular items or with particular stimulus dimensions. For example, the PE dimension, used most frequently by mentally retarded children at MA 12, may be the most familiar, thus evoking easy, rapid recognition. If a mechanism like this accounts for the performance difference between mentally retarded and normal-IQ children, there would be further support for the developmental delay (as opposed to

deficit) interpretation. Mentally retarded children of higher MA might attain dominance on this dimension, as do normal-IQ children at an earlier level.

While the performance differences on the choice task between the retarded and normal-IQ children can be explained either by difference in processing skills required for each task or by a possible delay in achieving dominance, retarded children's failure to explain their choices correctly seems more a function of deficient rather than delayed language ability. Retarded children appear to abstract critical attributes of stimulus dimensions at the symbolic level when making equivalence choices, but do not offer appropriate explanations, for either the perceptual or functional choices, as frequently as do their normal-IQ counterparts. Retarded children more frequently offered explanations which were not applicable to any of the four stimulus dimensions. That is, compared to normal-IQ children, more of their verbal explanations were characterized as a non-stimulus type, with more than half falling within the category "none", particularly as simple labelling responses. Systematic probing could be used to help determine the bases the children used for choosing particular equivalence matches.

However, one must also consider this as possibly a difference of opinion between experimenters and subjects. That is, the "right" answers, for both choices and explanations, were determined by fiat exercised by the investigator. Even though two independent judges were used to evaluate each of the items, the possibility remains that other relationships may exist, and be more potent, for the children who participated in the study. The high incidence of non-scorable explanations (i.e., those not conforming to any of the four dimensions) underscores the need to obtain more information about subjects'/children's bases

for forming relationships.

The effects of the stimulus dimensions appear to be very strong, perhaps obscuring other performance differences related to MA or IQ. Individual items need to be selected more carefully, relationships evaluated more thoroughly and strength of associations (distancing of stimuli) more systematically established psychometrically.

There appear to be complex interactions between the use of concepts to match stimuli and the use of the same concepts to explain the match. This seems to parallel the performance/ability distinction often encountered in studies of language function. All children in this study were evaluated by the PPVT, obviously a language measure. Despite this, there were noted discrepancies in performance. Perhaps groups need to be constituted on some other sort of language dimension and then their respective performances on this task compared. Alternatively, one might choose to compare explanations elicited in a competing stimulus condition with those elicited in a non-competing stimulus condition.

Further research in the area of concept usage seems warranted both to clarify more explicitly the language disparities found in this study and to detail differences in children below and above the mental age limits investigated in this study. However, it seems clear that any future investigations in the area of concept usage should be preceded by the development of a set of standardized items and procedures. Since different statements can be made about the preferential use of stimulus dimensions depending on whether the focus is performance across different mental age levels or within a particular mental age level, procedures for data collection and scoring should also be

more easily replicable.

Methodologies for teaching concepts to children share procedures similar to those used in this study in that they require children to (1) extract properties from their environment; (2) synthesize this information to form a "construct" and (3) apply this construct to other instances, which are more or less similar (generalization). Perceptible characteristics, such as color and shape are frequently used in teaching materials to direct attention. It appears though, that for the purpose of choosing similar items (i.e., applying concepts) that mentally retarded children (between mental ages 6-12) pay more attention to time and space relationships than to mere physical characteristics (shape). Also, simple functional relationships, FI dimensions of similar purposes and uses, are more often used than physical relationships (PI) and are sometimes equal in preference to time and space (PE) relationships. It might be useful to rearrange teaching content and materials to teach simple functional as well as time and space relations using visual materials to mentally retarded children within this mental age range. Also, it may be possible that simple functional relationships and time/space relationships can be used as the basis for teaching other relationships.

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